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Bianchetta

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[54] **FLUID CONTROL SYSTEM FOR MULTIPLE CIRCUITED WORK ELEMENTS**

[75] Inventor: **Donald Louis Bianchetta**, Coal City, Ill.

[73] Assignee: **Caterpillar Tractor Co.**, Peoria, Ill.

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[52] **U.S. Cl.** **91/6**; 60/486; 91/414

[58] **Field of Search** 91/412, 413, 414, 6; 60/427, 421, 484, 486

[56] **References Cited**

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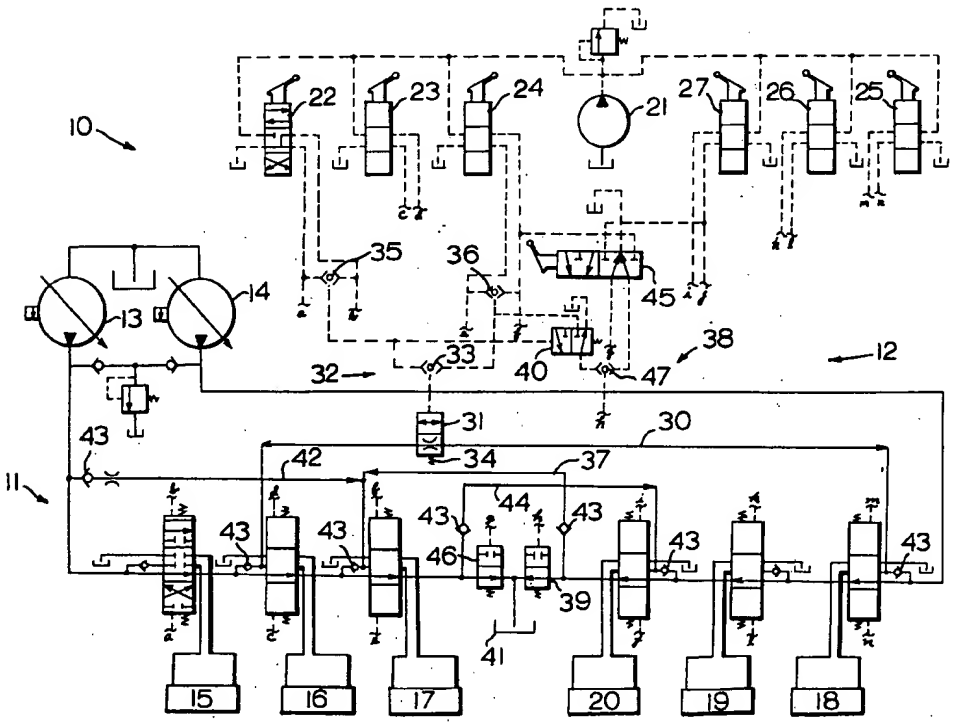
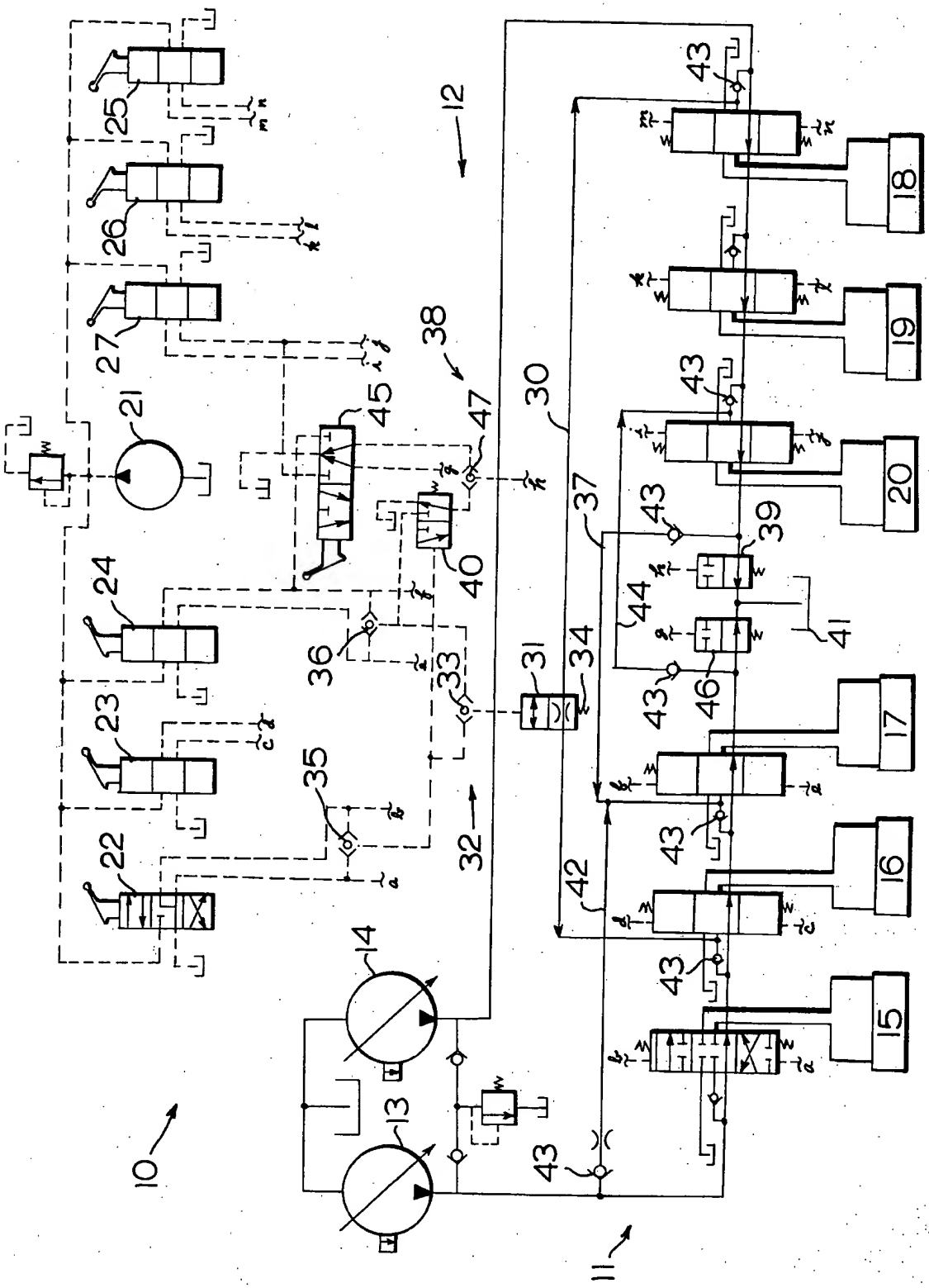
Primary Examiner—Martin P. Schwadron
Assistant Examiner—Abraham Hershkovitz
Attorney, Agent, or Firm—John L. James

[57] **ABSTRACT**

A fluid system has at least first and second circuits each having a plurality of work elements connected in interruptible series. Control elements are provided for selectively, automatically passing fluid from one circuit to preselected positions in the other circuit in response to operation of preselected work elements.

7 Claims, 1 Drawing Figure

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FLUID CONTROL SYSTEM FOR MULTIPLE CIRCUITED WORK ELEMENTS

BACKGROUND OF THE INVENTION

In the operation of a fluid system which serves work elements, such as for example the hydraulic system of an excavator which serves track, swing, stick, boom, and bucket work elements of the excavator, it is desirable to have a plurality of circuits and a plurality of work elements in each circuit. However, during operation of the excavator, it is often desirable to have additional fluid supplied to certain of the work elements under certain conditions. The problem then arises in being able to automatically supply this additional fluid under certain preselected conditions thereby avoiding placing additional requirements on the operator of manually manipulating additional controls to actuate the additional control elements.

The present invention is directed to overcome one or more of the problems as set forth above.

According to the present invention, a fluid system has first and second circuits each having a pump, a plurality of work elements connected in interruptible series, and a pilot pump connected to each work element through a respective control valve for controlling the operation of the work elements. A first fluid bypass line is connected at one end to the first circuit at a location between work elements of the first circuit and at the other end to the second circuit. A flow control valve is positioned in the first fluid bypass line. The flow control valve is movable between a first flow restricting position and a second open position. First means is provided for moving the flow control bypass valve to the second position in response to operation of selected work elements of the first circuit and for moving the valve to the first position in response to termination of operation of selected work elements of the first circuit. A second bypass line is connected at one end to the first circuit at a location between work elements of the first circuit and at the other end to the second circuit. Second means is provided for controllably passing fluid from the second circuit into the second bypass line in response to operation of preselected work elements of the first circuit.

BRIEF DESCRIPTION OF THE DRAWING

The drawing is a diagrammatic view of a fluid system having the apparatus of this invention.

DETAILED DESCRIPTION OF THE INVENTION

Referring to the drawing, a fluid system **10**, for example a hydraulic system of an excavator, has first and second circuits **11,12**. Each circuit **11,12** has respective pumps **13,14**, and first, second, and third work elements **15,16,17** (first circuit), **18,19,20** (second circuit). A pilot pump **21** is connected to each work element **15–20** through a respective control valve **22–27** for selectively controlling the operation of said work elements **15–20**.

A first bypass line **30** is connected at one end to the first circuit **11** at a location between work elements of said first circuit **11**, for example between elements **15,16**, and at the other end to the second circuit **12** at a location upstream of the first work element **18**.

A flow control valve **31** is positioned in the first bypass line **30**. The valve **31** is movable between a first flow restricting position shown, at which the flow of fluid through line **30** is substantially restricted, and a second open position at which the flow of fluid through line **30** is substantially unobstructed.

First means **32**, comprising a resolver valve **33** and associated fluid connections, is provided for moving the flow control valve **31** to the second position in response to operation of selected work elements of the first circuit **11** and for moving the valve **31** to the first position in response to termination of operation of selected work elements of the first circuit **11**.

In the preferred embodiment shown, the flow control valve **31** has a spring **34** urging the valve **31** to the first position and is connected to resolver valve **33** which in turn is connected to resolver valve **35** of the first control valve **22** of the first circuit **11** and connected to resolver valve **36** of the third control valve **24** of the first circuit **11**. Pressure signals delivered to the flow control valve **31** via resolver valve **33** therefore oppose the force of spring **34** and movement of the valve **31** from the first to the second position is in response to actuation of the first and/or third work element **15,17** of the first circuit **11**.

A second bypass line **37** is connected to one end of the first circuit **11** at a location between work elements of said first circuit, for example between elements **16,17**, and at the other end to the second circuit **12** at a location downstream of the work elements **18–20** of said second circuit **12**.

Second means **38**, comprising blocker valve **39** and directional control valve **40**, is provided for controllably passing fluid from the second circuit **12** into the second bypass line **37** in response to operation of preselected work elements of the first circuit, here for example work elements **15, 17**.

Blocker valves **39,46** are shown in their "open to tank" position and are movable, in response to receiving a pressure signal, to their second or blocked position. Directional control valve **40** is shown in its "to tank position" and is movable, in response to receiving a pressure signal, to its shifted position.

As can be seen from the drawing, a pressure signal is delivered to the directional control valve **40** from valve **22** in response to operation of work element **15**. This arrangement causes valve **40** to block any pressure signal to blocker valve **39** from valve **24** or allow a pressure signal to pass to blocker valve **39** in response to operation of work element **15**. Therefore, blocker valve **39** permits fluid to flow from the second circuit **12** to tank **41** in response to the nonoperation of both work elements **15** and **17**, and cause fluid to flow from the second circuit **12** into bypass line **37** in response to operation of both work elements **15** and **17**.

A third bypass line **42** can be provided for delivering fluid from upstream of the first work element **15** of the first circuit **11** into the second bypass line **37** for serving the third work element **17** of the first circuit **11**.

It should be noted that check valves **43** are associated with respective lines **30,37,42,44** for maintaining the direction of flow in said lines in the directions indicated by the arrows.

A manually operated selector valve **45** can be provided for passing fluid from the first circuit **11** at a location downstream of the last work element **17** into the second circuit at a location upstream of work element **20**. Valve **45** is shown in the tank position at which signals from control valves **24** and **27** are blocked and said valve **45** is manually shiftable to a second position at which signals from control valves **24,27** can pass respectively to blocker valve **39** via resolver **47** and to

blocker valve **46**, thereby selectively, controllably directing excess fluid from the tail end of each circuit **11,12** to the other circuit.

For purposes of simplicity in comprehending the operation of the fluid system of this invention, in the first circuit **11** the first work element is a swing **15**, the second work element is left track apparatus **16** and the third work element is a stick **17**, and in the second circuit **12** the first work element is right track apparatus **18**, the second work element is a bucket **19** and the third work element is a boom **20**. The work elements **15–17** of the first circuit **11** and the work elements **18–20** of the second circuit **12** are connected in interruptible series, as set forth above.

By the construction of the fluid system of this invention, fluid is automatically directed from one position in one of the circuits to another position in the other circuit in response to the operation of the various work elements. The following table is provided to set forth some of the various modes of operation of the system. Other modes of operation can easily be discovered by a study of the drawing and specification.

TABLE

Work Elements in Operation	Element No.	Position	Effect on Associated Elements: Element No.	Effect
15,16,18	31	2nd Position	39	Open to tank
	40	Shifted Position	46	Open to tank
			16	Receives fluid via line 30 and any excess fluid from 15
16,18	31	1st Position	39	Open to tank
	40	To Tank Position	46	Open to tank
			16,18	Receives equalizing fluid pressure via line 30 as needed
15,17	31	2nd Position	39	Blocked
	40	Shifted Position	46	Open to tank
			17 Receives fluid from 2nd	circuit via lines 37, from line 42, and excess fluid from 15
15,16,17,18	31	2nd Position	39	Blocked
	40	Shifted Position	46	Open to tank
			16	Receives fluid from 2nd circuit via line 30, excess fluid from 15
			17	Receives excess fluid from 18 via line 37, fluid from line 42, and excess fluid from 16
20	31	1st Position		
	40	Tank Position	39	Open to tank
	45	2nd Position	46	Blocked
			20	Receives fluid from 1st circuit via line 44 in conjunction with 2nd circuit
17	31	2nd Position		
	40	Tank Position	39	Blocked
	45	2nd Position	46	Open to tank
			17	Receives fluid from 2nd circuit via line 37 and fluid from first circuit

It should be understood, however, that the control elements of this invention, namely elements **31,40,45**, can be constructed to receive signals from other work elements and be positioned at other locations in the fluid system without departing from this invention. Further, there can be additional control elements for automatically rerouting the fluid without departing from this invention.

Other aspects, advantages, and objects of this invention can be obtained from a study of the drawing, the disclosure, and the appended claims.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. In a fluid system having at least first and second circuits each having a fluid source, a reservoir, a plurality of work elements connected in interruptible series, a work fluid pathway for each circuit, said work fluid pathways comprising a passageway connecting each source to the work elements of the respective circuit and to the reservoir, and a pilot pump connected to each work element through a respective control valve for controlling the operation of said work element, the improvement comprising:

a first bypass line separate from said work fluid pathways and being connected at one end to the first circuit at a location between work elements of said first circuit and at the other end to a preselected location on the second circuit;

a flow control valve positioned in the first bypass line, said flow control valve being movable between a first flow restricting position and a second open position;

first means for moving the flow control valve to the second position in response to operation of selected work elements of the first circuit and for moving the valve to the first position in response to termination of operation of selected work elements of the first circuit;

a second bypass line separate from said work fluid pathways and being connected at one end to the first circuit at a preselected location and at the other end to a preselected location on the second circuit; and

second means f r controllably passing fluid from the second circuit into the second bypass line in response to operation of preselected work elements of the first circuit.

2. A fluid system, as set forth in claim 1, including:

a third bypass line having one end connected to the first circuit at a location upstream of the work elements of said first circuit and the other end connected to the second bypass line.

3. A fluid system, as set forth in claim 2, wherein the first circuit has at least three work elements connected in interruptible series with the first bypass line connected to the first circuit between the first and second work elements and the second bypass line connected to the first circuit between the second and third work elements.

4. A fluid system, as set forth in claim 1, wherein the first circuit has at least three work elements connected in interruptible series with said first bypass line connected to the first circuit between the first and second work elements and the second bypass line connected to the first circuit between the second and third work elements.

5. A fluid system, as set forth in claim 1, wherein the first circuit has at least three work elements connected in interruptible series and the first means comprises:

a resolver valve connected to the respective control valves of the first and third work elements and to the flow control valve of the first bypass line.

6. A fluid system, as set forth in claim 1, wherein the first circuit has at least three work elements connected in interruptible series and the second means comprises:

a blocker valve in the second circuit at a location downstream of the work elements of said second circuit; and

a directional control valve connected to the first and third work elements of the first circuit and to the blocker valve of the second circuit and being of a construction sufficient for passing fluid from the second circuit into the second bypass line in response to operation of both first and third work elements of said first circuit.

7. A fluid system, as set forth in claim 1, including:

means for passing fluid from the first circuit downstream of the last work element into the second circuit in response to manual positioning of a selector valve.

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